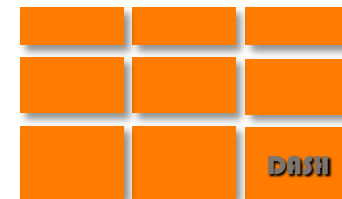


EXHIBIT 15



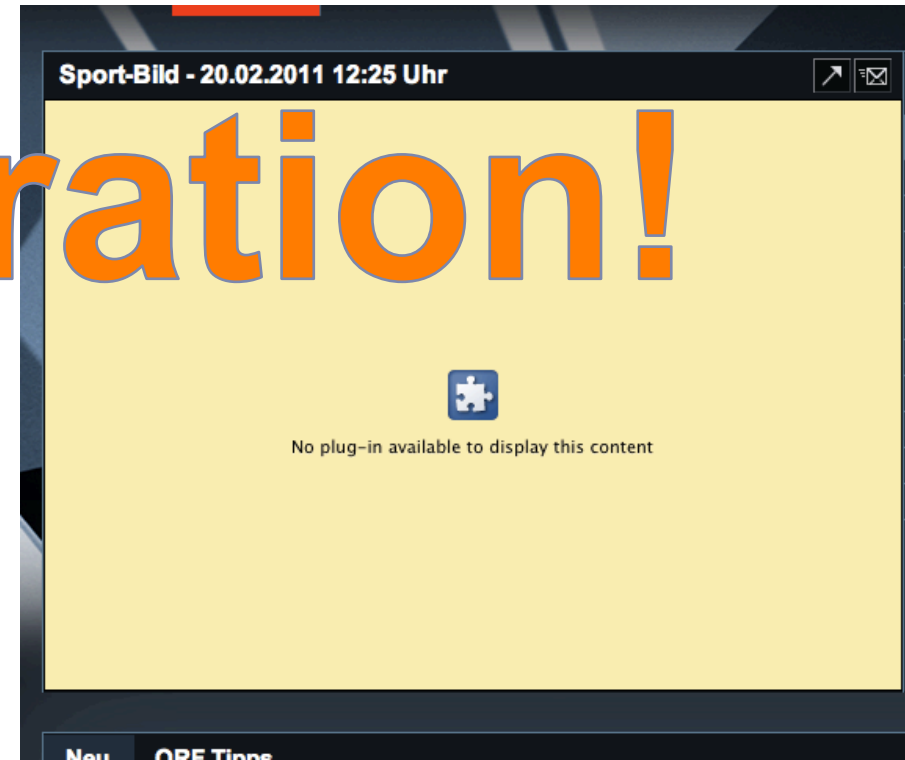
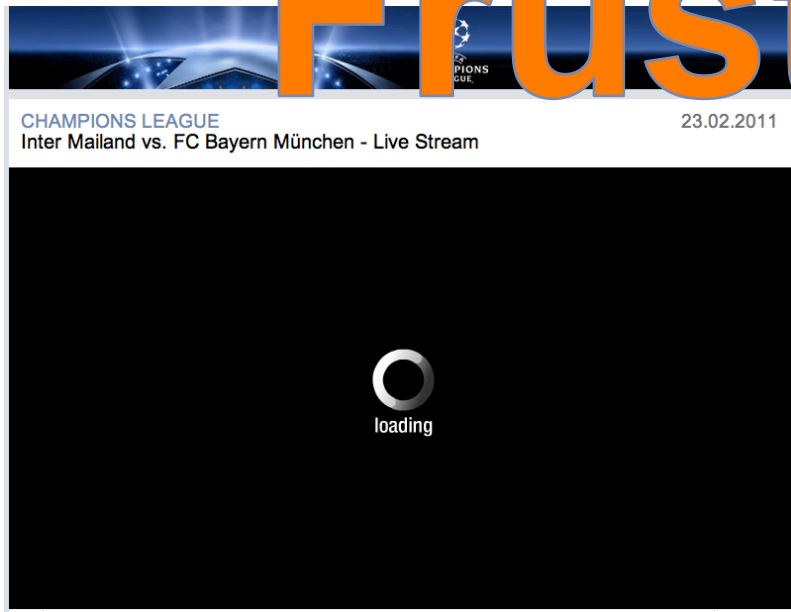
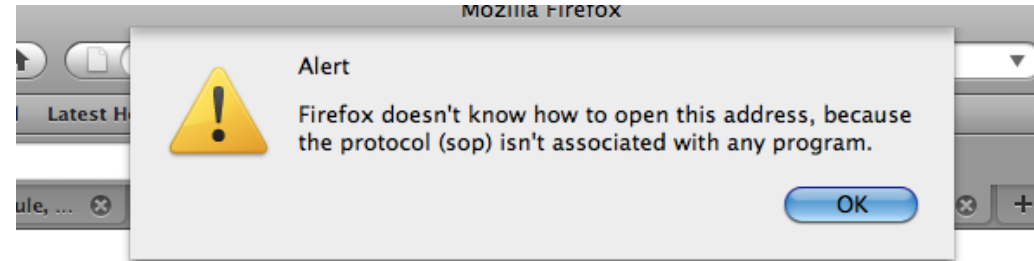
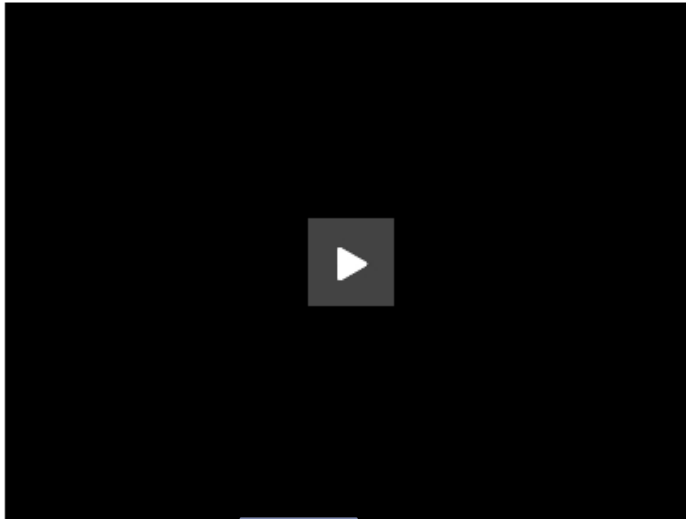
Dynamic Adaptive Streaming over HTTP

– Design Principles and Standards

Thomas Stockhammer, Qualcomm



Internazionale vs Bayern Munchen

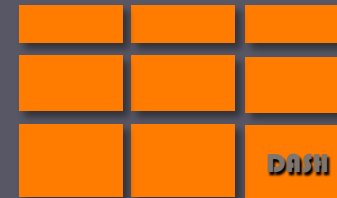


Frustration!

User Frustration in Internet Video

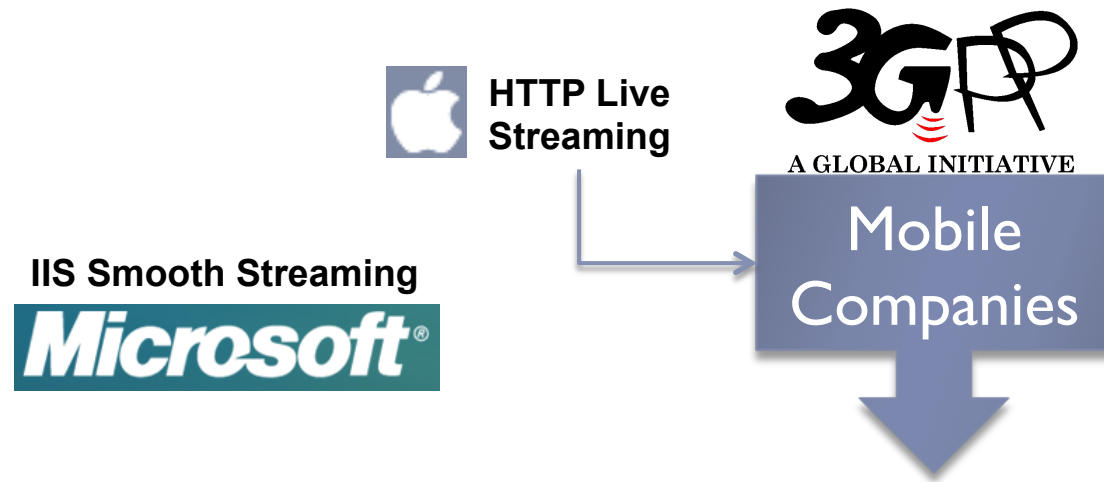
- ▶ Video not accessible
 - ▶ Behind a firewall
 - ▶ Plugin not available
 - ▶ Bandwidth not sufficient
 - ▶ Wrong/non-trusted device
 - ▶ Wrong format
- ▶ Fragmentation
 - ▶ Devices
 - ▶ Content Formats
 - ▶ DRMs
- ▶ Low quality of experience
 - ▶ Long start-up delay
 - ▶ Frequent Rebuffering
 - ▶ Low playback quality
 - ▶ No lip-sync
 - ▶ No DVD quality (language, subtitle)
- ▶ Expensive
 - ▶ Sucks my bandwidth
 - ▶ Need a dedicated device
 - ▶ Other costs ...





One way to build confidence -
Open Standards

DASH: Standardization History and Status



Why in 3GPP?

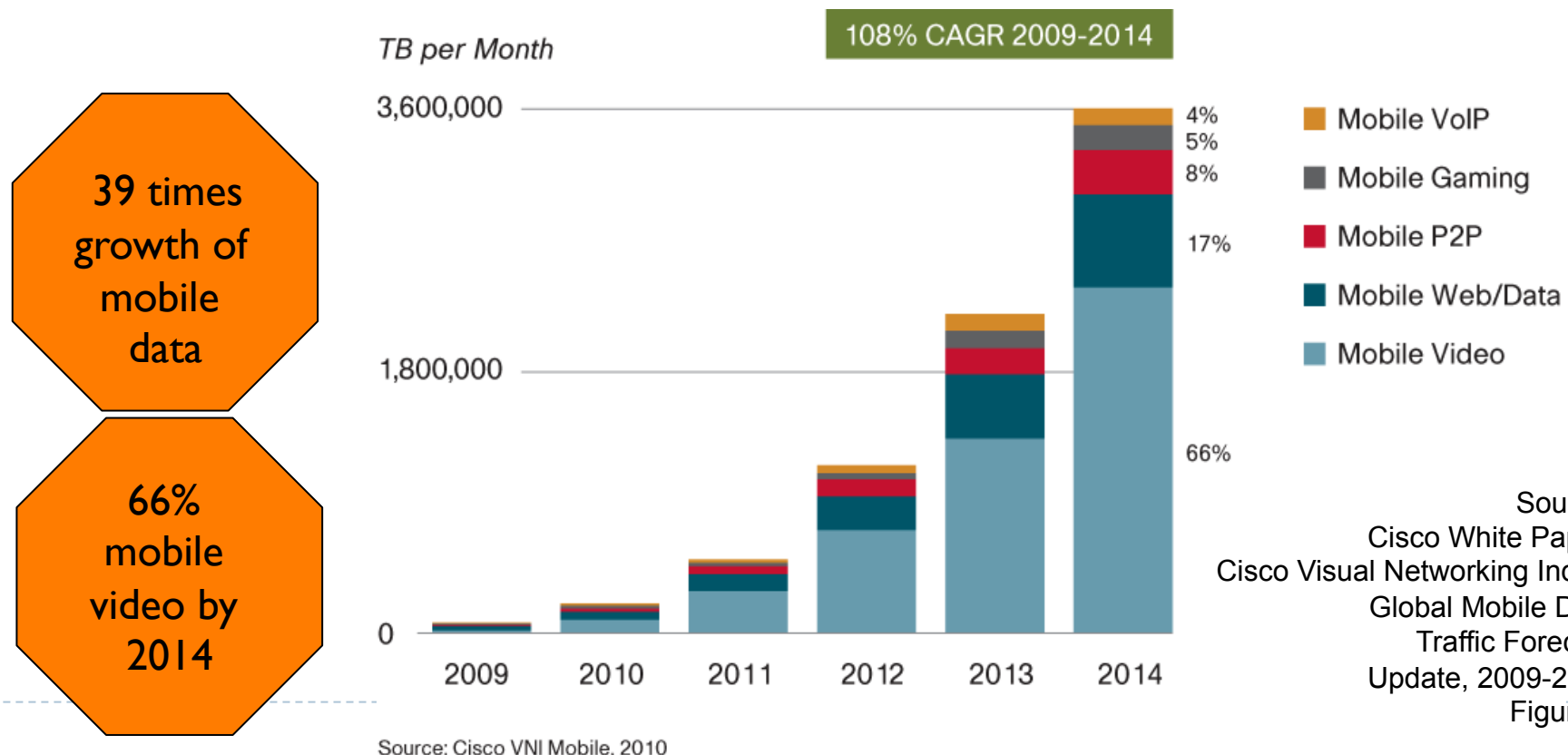
The Mobile Video Streaming Challenge

► The mobile video landscape

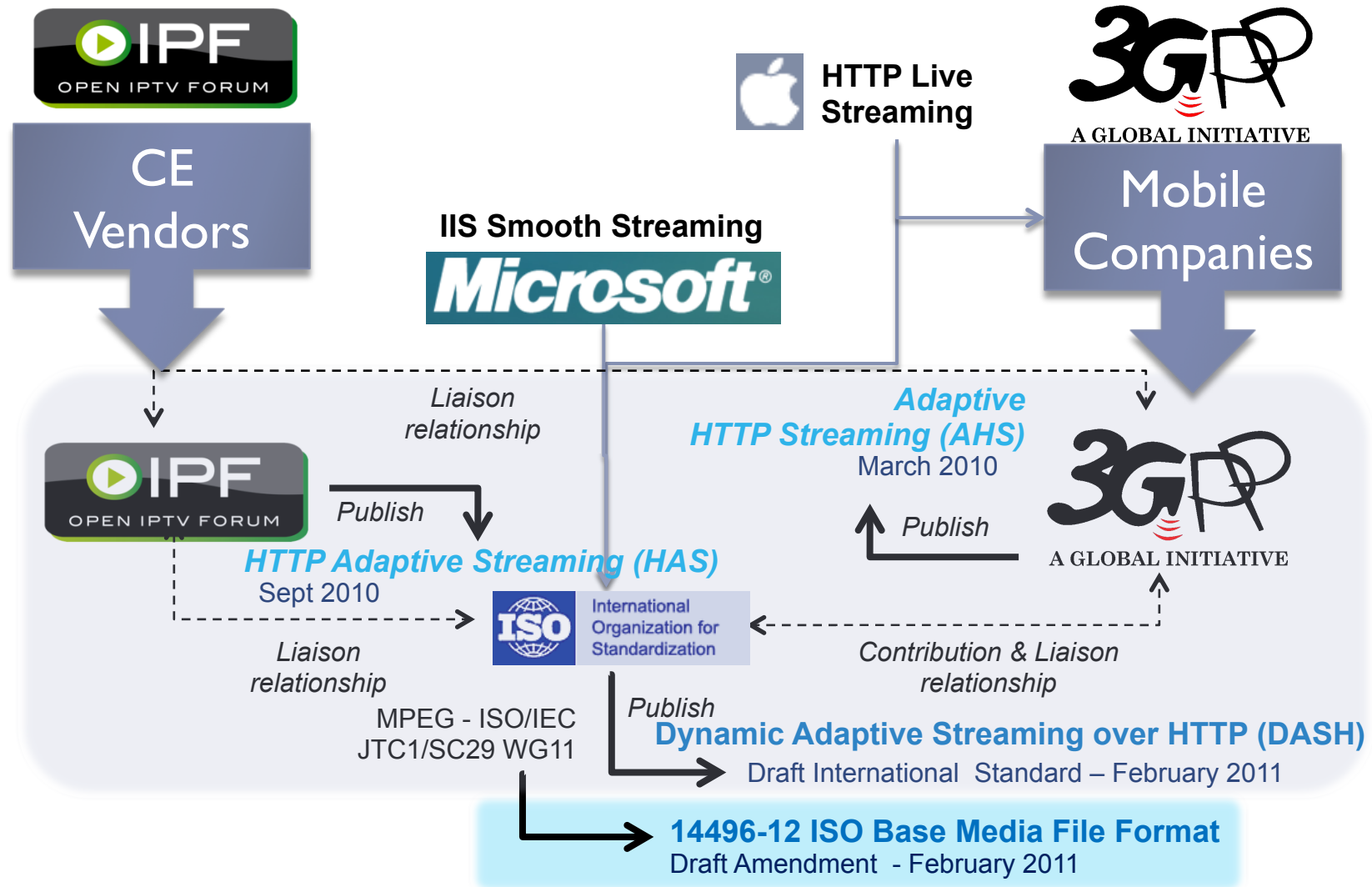
- Mobile Internet use is dramatically expanding
- Video traffic is growing exponentially & is a large fraction of the usage

► The challenges

- Mobile users expect high quality video **experience**
- Network operators need to offer quality experience affordably



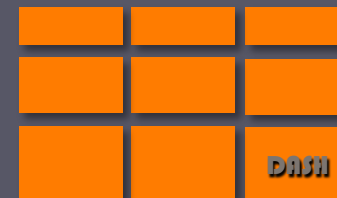
Standardization History and Status



MPEG DASH ISO/IEC 23001-6

- ▶ MPEG DASH ISO/IEC 23001-6 is now the master specification
- ▶ Provides a superset for system specifications
 - ▶ 3GPP Release-9 AHS
 - ▶ Open IPTV Forum HTTP Adaptive Streaming
 - ▶ 3GPP Release-10 DASH (completion target July 2011)
 - ▶ System specifications may define more: codecs, DRM, etc.
- ▶ Timeline and Activities
 - ▶ Draft International Standard (DIS) 23001-6 available publicly
 - ▶ 5 months balloting period until July 2011
 - ▶ Parallel approval process for extensions to ISO base media FF to support DASH
 - ▶ Continuous coordination with 3GPP and other organizations (DECE, OIPF, etc.)
 - ▶ Conformance and Reference Software activities kicked off (see WD 23001-7)
- ▶ The good news: Converging standard for adaptive streaming on the way

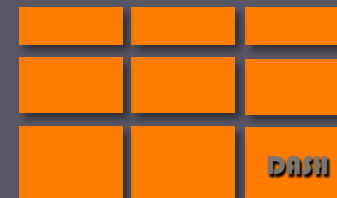
Convergence = Confidence



DASH Design Principles

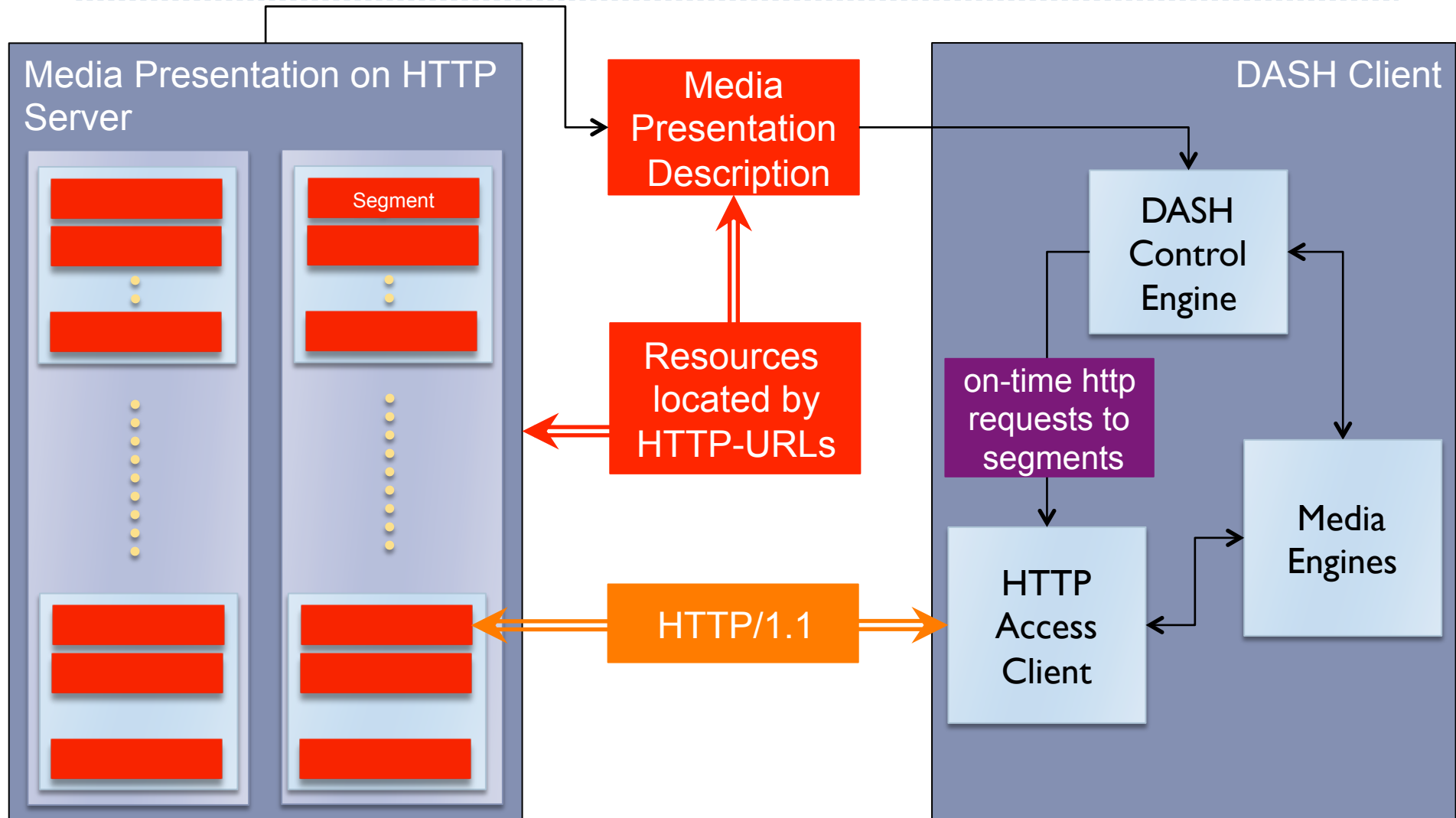
(Some) DASH Design Principles

- ▶ DASH is not:
 - ▶ system, protocol, presentation, codec, interactivity, client specification
- ▶ DASH is an **enabler**
 - ▶ It provides **formats** to enable efficient and high-quality delivery of streaming services over the Internet
 - ▶ It is considered as one component in an e2e service
 - ▶ System definition left to other organizations (SDOs, Fora, Companies, etc.)
- ▶ It attempts to be very good in what is to be addressed by the standard
 - ▶ Enable reuse of existing technologies (containers, codecs, DRM etc.)
 - ▶ Enable deployment on top of HTTP-CDNs (Web Infrastructures, caching)
 - ▶ Enable very high user-experience (low start-up, no rebuffering, trick modes)
 - ▶ Enable selection based on network and device capability, user preferences
 - ▶ Enable seamless switching
 - ▶ Enable live and DVD-kind of experiences
 - ▶ Move intelligence from network to client, enable client differentiation
 - ▶ Enable deployment flexibility (e.g., live, on-demand, time-shift viewing)
 - ▶ Provide simple interoperability points (profiles)



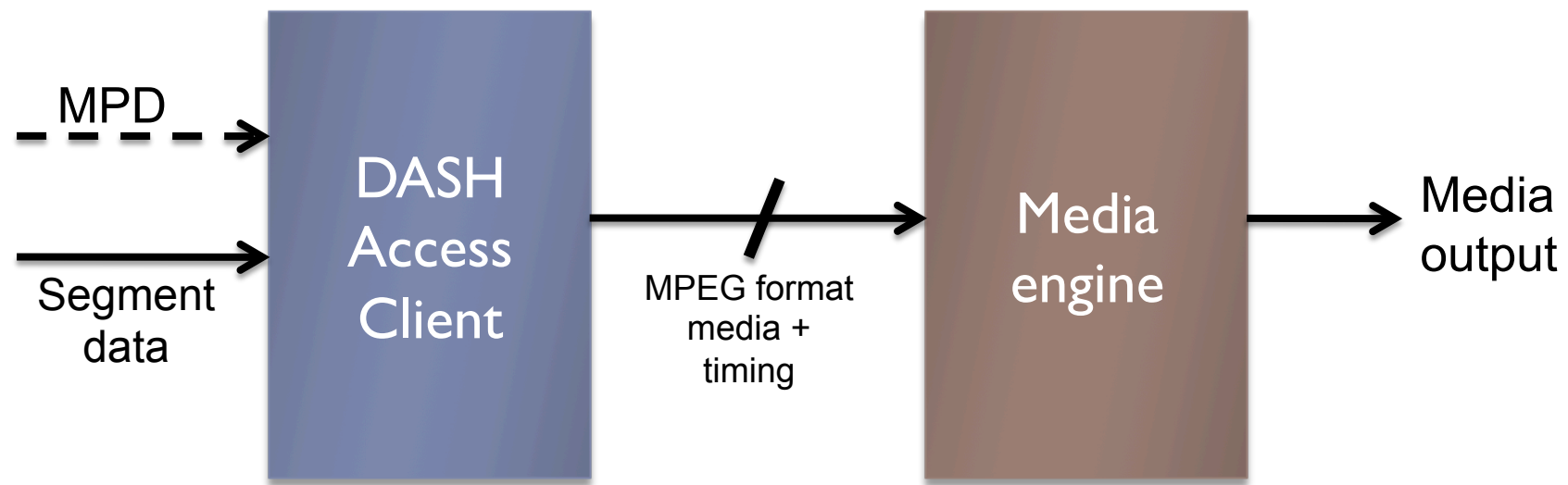
DASH Specification Insights

What is **specified** – and what is not?



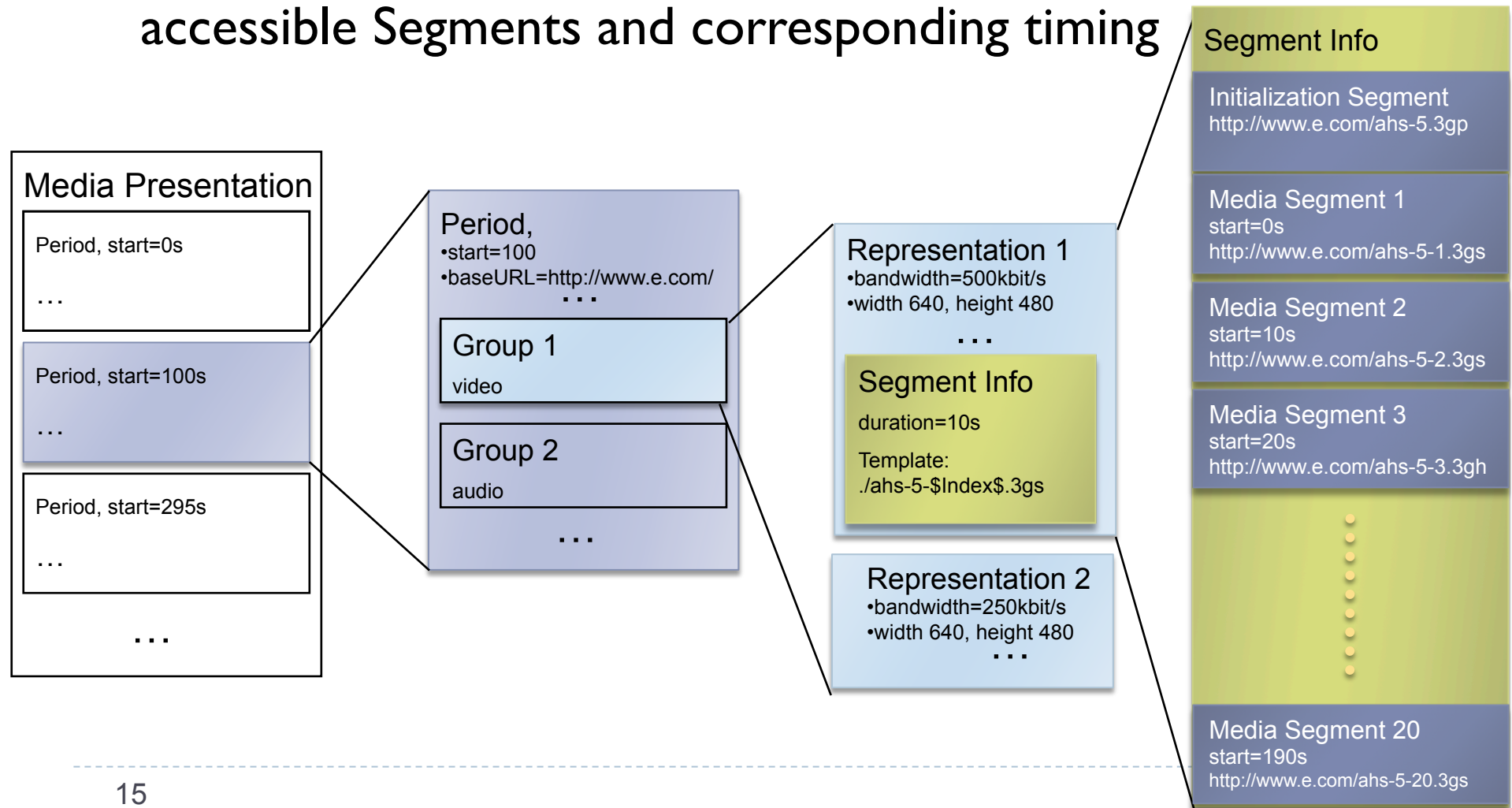
Information Classification

- ▶ MPD and Index Information for DASH Access client
 - ▶ Core specification aspects of DASH
- ▶ Initialisation and Media Segments for Media engine
 - ▶ Reuse of existing container formats and easy conversion
 - ▶ Small adaptations may be necessary for usage in DASH



Media Presentation Data Model

- ▶ Media Presentation Description (MPD) describes accessible Segments and corresponding timing



MPD Information

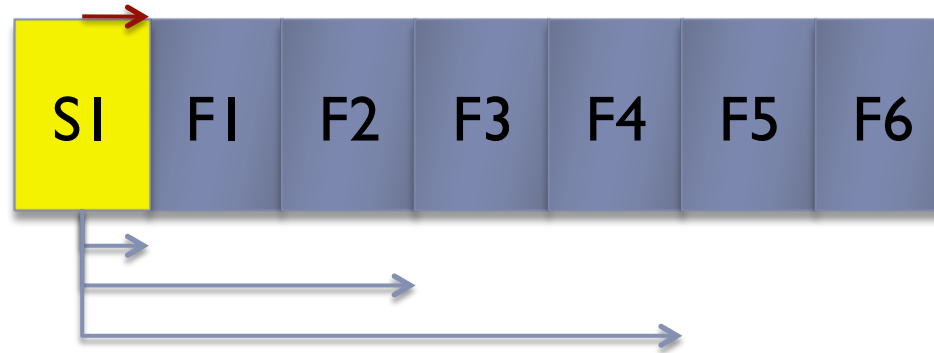
- ▶ Redundant information of Media Streams for the purpose to initially select or reject Groups or Representations
 - ▶ Examples: Codec, DRM, language, resolution, bandwidth
- ▶ Access and Timing Information
 - ▶ the HTTP-URL(s) and byte range for each accessible Segment
 - ▶ the earliest next update of the MPD on the server
 - ▶ the segment availability start and end time in wall-clock time
 - ▶ the approximated media start time and duration of a Media Segment in the media presentation timeline
 - ▶ for live service, instructions on starting playout such that media segments will be available in time for fluent playout in the future
- ▶ Switching and splicing relationships across Representations
- ▶ Relatively little other information

Segment Indexing

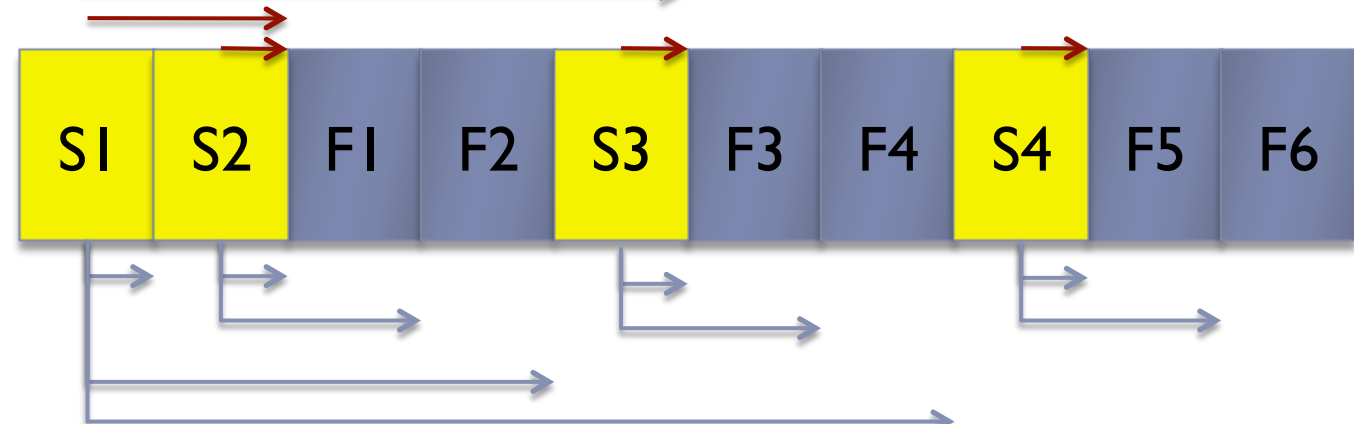
- ▶ Provides binary information in ISO box structure on
 - ▶ Accessible units of data in a media segment
 - ▶ Each unit is described by
 - ▶ Byte range in the segments (easy access through HTTP partial GET)
 - ▶ Accurate presentation duration (seamless switching)
 - ▶ Presence of representation access positions, e.g. IDR frames
- ▶ Provides a compact bitrate-over-time profile to client
 - ▶ Can be used for intelligent request scheduling
- ▶ Generic Data Structure usable for any media segment format, e.g. ISO BMFF, MPEG-2 TS, etc.
- ▶ Hierarchical structuring for efficient access
- ▶ May be combined with media segment or may be separate

Media Segment with Segment Index

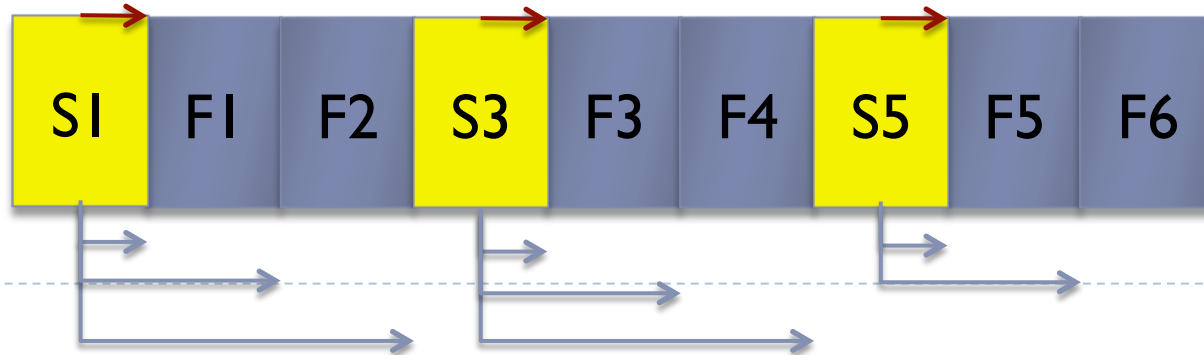
► Simple



► Hierarchical



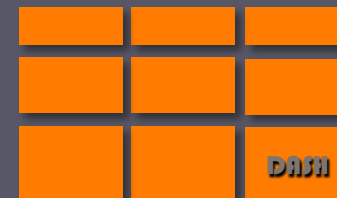
► Daisy-Chain



Media Segments

- ▶ Contain information to map segment into media presentation timeline for switching and synchronous presentation with other Representations
- ▶ For ISO BMFF, contains one or more movie fragments
- ▶ Can be short (≈ 1 -10 sec) and long (≈ 10 sec – 2h)

Segment duration	Advantages	Disadvantages
Short	<ul style="list-style-type: none"> • Commonality with Live • High switching granularity on segment level 	<ul style="list-style-type: none"> • Large number of files • Large number of URLs • Fixed request size • switching granularity on segment level
Long	<ul style="list-style-type: none"> • Small number of files • Small number of URLs • High switching granularity • Flexible request sizes • Improved cache performance 	<ul style="list-style-type: none"> • Need for Segment Index • Difference from Live



DASH Selected Features

DASH Selected Feature list

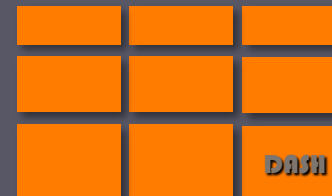
- ▶ Live, On-Demand and Time-shift services
- ▶ Independency of request size and segment size (byte range requests)
- ▶ Segment formats
 - ▶ ISO base media FF and MPEG-2 TS
 - ▶ guidelines for integrating any other format
 - ▶ Are codec independent
- ▶ Support for server and client-side component synchronization (e.g., separate and multiplexed audio and video)
- ▶ Support for efficient trick mode
- ▶ Simple splicing and (targeted) ad insertion
- ▶ Definition of quality metrics
- ▶ Profile: restriction of DASH and system features (claim & permission)
- ▶ Content Descriptors for Protection, Accessibility, Rating, etc.
 - ▶ Enables common encryption, but different DRM (DECE-like)

Forward looking

- ▶ **Do the homework**
 - ▶ Specification completion in the next few months
 - ▶ Conformance, interoperability and reference software
- ▶ **DASH is rich and simple at the same time**
 - ▶ Understand more detailed market needs
 - ▶ Create profiles as considered necessary
 - ▶ Collaborate with system creators on how to integrate DASH
- ▶ **Integrate it into the web – what is necessary?**
- ▶ **Get it deployed**
- ▶ **Everyone is invited - get involved in and excited about DASH**



Confident?
Or more
Chocolate?



Thank you

Comments – Questions - Feedback